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Patent
Attorney's Docket No. 027500-386

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT
APPLICATION TRANSMITTAL LETTER

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Enclosed for filing is the utility patent application of Paul W. DENT, Bengt PERSSON and Bjorn GUDMUNDSON for MOBILE ASSISTED HANDOVER USING CDMA.

Also enclosed are:

[X] 3 sheet(s) of [ ] formal [X] informal drawing(s);

[ ] a claim for foreign priority under 35 U.S.C. §§ 119 and/or 365 in [ ] a separate document [ ] the declaration;

[ ] a certified copy of the priority document;

[ ] an Associate Power of Attorney;

[ ] _____ verified statement(s) claiming small entity status; and

[ ] an Assignment document.

The declaration of the inventor(s) [ ] also is enclosed [X] will follow.

The fee has been calculated as follows:

CLAIMS					
	NO. OF CLAIMS		EXTRA CLAIMS	RATE	FEE
Basic Application Fee					$ 690.00
Total Claims	15	MINUS 20 =	-0-	x $20 =	-0-
Independent Claims	5	MINUS 3 =	2	x $72 =	144.00
If multiple dependent claims are presented, add $220.00					-0-
Total Application Fee					834.00
If verified statement claiming small entity status is enclosed, subtract 50% of Total Application Fee					-0-
Add Assignment Recording Fee of $40.00 if Assignment document is enclosed					-0-
TOTAL APPLICATION FEE DUE					**834.00**

(BDSM 13)
(12/91)

[X] A check in the amount of $ 834.00 is enclosed.

[ ] Charge $_____ to Deposit Account No. 02-4800.

The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16, 1.17, and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. A duplicate of this paper is enclosed.

Respectfully submitted,

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UNITED STATES APPLICATION FOR

LETTERS PATENT

FOR

MOBILE ASSISTED HANDOVER USING CDMA

BY

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MOBILE ASSISTED HANDOVER USING CDMA

BACKGROUND

In mobile radio telephone systems, the capability is provided to transfer the handling of communications with a mobile station from one base station to another, as the mobile station changes its position and so moves out of the coverage range of one base station and into the coverage area of another base station. This process is commonly termed handover or handoff.

To smoothly complete a handover, the network controlling the base stations must first determine, for each mobile station, whether the need for handover is imminent and secondly determine to which new base station handover should be effected. In making the latter decision it is desirable that the network controller know either how well each base station can receive signals from a mobile station in question, or how well the mobile station in question can receive signals from each base station, or both. The present invention provides a method for the base station to acquire this information using a code division multiple access (CDMA) transmission method.

Conventional mobile telephone systems were based largely on Frequency Division Multiple Access (FDMA), in which each mobile station transmits on a unique frequency within its current base station area. The mobile station is thus unaware of signals on other frequencies from surrounding bases. In FDMA systems it would be too costly to equip mobile stations with an extra receiver that could be used to scan other base frequencies. Instead, it is established practice that base stations are equipped with a scanning receiver that looks out for the signals of approaching mobile stations. The network then hands over a mobile from a base station covering an area it is leaving to the base station that

reports the best reception of the mobile station's signal.

More recent cellular telephone standards employ Time Division Multiple Access (TDMA) in which a fixed time period (e.g., 20 mS) on each radio frequency is divided into a number (e.g., 3) of short timeslots (e.g., 6.6 mS) that are cyclically used by different mobile stations. Thus, a first mobile station transmits in the first timeslot in each period, a second mobile station transmits in the second timeslot in each period and so on. Likewise the base station transmits to one mobile station in the first timeslot, another mobile station in the second slot and so on. By offsetting the allocation of timeslots in the two communications directions, base to mobile (the downlink) and mobile to base (the uplink), it can be arranged that a first mobile transmits in the first timeslot and receives in the second timeslot; a second mobile transmits in the second timeslot and receives in the third, while a third mobile transmits in the third timeslot and receives in the first timeslot. An advantage of this arrangement is that a mobile station does not need to transmit and receive simultaneously, which facilitates sharing a single antenna.

In the above three-timeslot example, each mobile station is active to transmit or receive in two of the three timeslots and idle in the remaining timeslot. Therefore it is possible for TDMA mobile stations to use this idle time to search for signals from other base stations and measure their signal strength. By reporting these signal strength measurements to the base station using a slow speed data channel multiplexed with the traffic (i.e., voice), the network is informed about the base stations each mobile station can receive. The network can use this information to effect handover to the best base station, and such a system is termed mobile assisted handover (MAHO). When the base stations scan

for the signal strength of mobile stations, the system could be termed base assisted handover (BAHO).

Systems providing MAHO also have access to the base station measurements, and so are able to effect smoother and more reliable handovers because both uplink and downlink signal strengths are taken into account, instead of just uplink strengths in the case of BAHO. However, these conventional systems have a number of limitations. For example, MAHO has conventionally only been used in TDMA systems. TDMA systems, however, involve a certain waste of capacity due to the need for guard spaces between timeslots during which the mobile stations' transmitters power up and down. Moreover, in these TDMA systems with MAHO, fast frequency switching is needed to scan channels on which other base stations are transmitting during the short idle periods, which is technically difficult and adds both complexity and cost to the system. The available time in the idle slot combined with the difficulty in switching frequency rapidly permit only one neighboring base frequency to be scanned per 20 mS frame. In FDMA systems, MAHO has not been implemented because base stations in FDMA systems use different frequencies to transmit control channels than those being used by mobile stations for transmissions and FDMA mobiles cannot change frequency without loss of traffic.

The present invention uses Code Division Multiple Access (CDMA) to permit neighboring base stations to share the same frequency channel, and thus permit the mobile to assess their signal strength without changing frequency or losing traffic. Another feature of the present invention is that the signals generated by the neighboring base station to which the mobile station is being handed over comprise a diversity transmission which can be combined with the transmissions from the base station originally connected to the mobile station to improve reception quality.

Conventionally, such diversity transmissions have been provided in CDMA systems by transmitting a signal which is encoded and modulated in exactly the same way as the original signal with a relative delay of one or more chips or bits. These overlapping signals can then be combined in an echo-integrating type of receiver such as a Viterbi equaliser or a RAKE receiver.

A disadvantage of these conventional macrodiversity systems is the need to transmit from one base station the codes that are ~~allocated~~ being used to transmit to the mobile station to one or more other base stations. In a subtractive CDMA system, this also involves informing all of the mobile stations in a cell when a diversity transmission for any mobile is initiated of the exact code that will be used.

This problem is overcome according to the present invention by using different codes for the diversity transmissions so that an originally connected base station need not transmit an allocated code to other base stations. This takes advantage of the fact that a CDMA mobile receiver is able to simultaneously receive and decode both its normally coded signal and the diversity coded signal.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features, and advantages of the present invention will become more apparent by reading the following detailed description in conjunction with the drawings in which:

Figure 1 illustrates a block diagram of a transmitter/receiver according to the present invention;

Figure 2 illustrates the control unit of Figure 1 in more detail; and

Figure 3 shows a network control system for performing handovers between base stations according to the invention.

DETAILED DESCRIPTION

The present invention will now be described in the context of a subtractive CDMA demodulation system, such as that disclosed in U.S. Patent ~~Application Serial No. 07/628,359,~~ No. 5,151,919 entitled "CDMA Subtractive Demodulation" which was filed on December 17, 1990 and is hereby incorporated by reference. However, those skilled in the art will readily appreciate that the present invention is applicable to any system in which adjacent base stations operate on the same frequency and use signals with coded features enabling them to be distinguished.

In the above mentioned application, a system is described in which coded signals are scrambled with unique scrambling codes and then transmitted on the same frequency. A plurality of overlapping signals received on a single frequency channel include a number of signals within the same cell as well as a number of signals transmitted from base stations in neighboring cells. Despite overlap in time and frequency, individual signals can be selected for decoding by first descrambling the received signal with the appropriate scrambling code and then decoding the underlying information bearing code. Undesired interfering signals do not descramble to a form that correlates with the decoding and so are suppressed to a certain degree called the processing gain. An exemplary underlying information coding is bi-orthogonal or orthogonal coding using Walsh-Hadamard functions. The suppression of interference caused by the other signals transmitted on the same frequency is enhanced by the subtractive CDMA demodulation system disclosed in the aforementioned patent application by descrambling and decoding signals in signal strength order from strongest to weakest and subtracting each signal from the received composite signal as it is decoded. In that way, stronger signals do not substantially interfere with weaker ones

and it is easier to then decode the weaker signals, such as might be received from more distant stations.

The general arrangement of an exemplary transmitter/receiver according to the invention is shown in Figure 1. A CDMA decoder 10 receives a composite signal via an antenna 11, suitable amplifying, filtering and downconverting by signal processing circuitry 12 and A to D convertor 13. The A to D convertor 13 produces complex number outputs and can operate, for example, according to the logpolar principle described in U.S. Patent No. 5,048,059, which is hereby incorporated by reference. The CDMA decoder is programmable by means of control unit 14 with any of a number of unique descrambling codes corresponding to the overlapping signals contained in the composite received signal. These descrambling codes are presented to the decoder in descending order of signal strength of the associated signal. The decoder furnishes decoded information and signal strength measurement information back to the control unit. Signal strength information can include amplitude and phase information, not only for the direct ray received from any station but also for delayed echoes. The direct ray and echo information is processed, for example by filtering and summing, to determine the total received energy in each signal. If signals are detected to have altered their position in signal strength sorted order, or are predicted to be about to do so, the control unit can alter the order of decoding in the next period. Decoded information contained in at least one of the decoded signals informs the control unit about the scrambling codes and/or frequencies of the cell from which that signal was generated and/or the codes and frequencies of neighboring cells. Similarly, outgoing traffic is encoded by CDMA encoder and modulator 19, upconverted for transmission by upconvertor 15 and amplified by power amplifier 16 before being transmitted from antenna 11. The output power

level can be controlled by control unit 14 at both the encoder 19 and power amplifier 16 over control bus 18. The control unit 14 can also perform frequency programming for both received signals and transmission signals over control bus 9.

One way in which these scrambling codes can be constructed is to bitwise modulo-2 add one of a number (e.g. 7) of base station ID codes to one of a number (e.g. 32) of traffic channel ID codes, as described in U.S. Patent Application Serial No. 07/846,865, entitled "Multiple Access Coding", which was filed on April 10, 1992 and is hereby incorporated by reference. Moreover, one of the traffic channel ID codes can be reserved in each cell for use as a broadcast channel, calling channel or pilot channel as described in U.S. Patent Application Serial No. 08/306,470, entitled "Calling Channel in CDMA Communications System", filed on April 13, 1992 and is hereby incorporated by reference. The signal using this code is always the strongest signal so the mobile receiver knows it shall attempt decoding of that signal before any other signals from the same cell.

The seven base station ID codes can be allocated to cells in a so-called 7-cell pattern such that no two adjacent cells use the same ID code. However, the use of codes will generally be repeated two cells or more away, so there can be ambiguity due to propagation anomalies as to whether a signal decoded using a particular code is from an adjacent cell or further away. Upon successfully decoding a broadcast channel, further information is obtained on the station ID to resolve this ambiguity. An advantage of restricting the number of base station ID codes is that the receiver only need attempt decoding with this limited number of codes, thereby accelerating the decoding process.

Normally, a receiver only need decode and subtract signals in descending signal strength order

until it decodes its own traffic channel. If the mobile station is near the edge of its cell and thus possibly about to require handover to an adjacent cell, its traffic signal will be one of the stronger signals demodulated early, as will the calling channel of an adjacent cell, so it is not necessary to decode many signals in order to acquire the desired information. If, on the other hand, the mobile station is near the center of its own cell, the base station will allocate less downlink power to signals sent to the mobile and its signal will be among the weaker ones received. When this situation arises, the mobile station can deduce that it is not on the edge of its current cell and thus not about to require handover.

The mobile station can nevertheless attempt to demodulate the calling channel of a neighboring cell, even when the signal strength of such a calling channel is below that of the mobile station's traffic channel, by continuing to decode received signals after extracting its own traffic signal. In this way, the system can predict when the received signal strength of a relatively strong calling channel of a neighboring base station will exceed the signal strength of the mobile station's own signal, so that the stronger signal will be subtracted first.

When the mobile receiver detects from relative signal strengths that it is nearing a point where a handover might be appropriate, the base station is informed by data message from the mobile station about the other base stations the mobile station can hear and their relative signal strengths. This process of signal strength reporting can also be continuous even when handover is not imminent. In order for such control-type messages not to interrupt traffic flow, it is conventionally known to multiplex a low bit rate data stream called the Slow Associated Control Channel (SACCH) with the higher bit rate traffic. It is also possible,

if the need for handover becomes more urgent, to steal capacity from the traffic channel to send a high priority message. Conventionally, such a priority message channel is known as a Fast Associated Control Channel (FACCH).

In exemplary embodiments of the present invention, the base station or fixed network includes processing circuitry to decide, for each mobile station, when handover is necessary and to implement handover at such times. At least three forms of handover can be executed by a mobile station under control of the intelligent network controller as follows.

A first form, called an internal handover, occurs when the network decides to keep the mobile station connected to its current base station for traffic sharing or capacity optimization reasons, but to switch transmissions from the mobile station to another frequency or code. If a frequency change is commanded, a slight interruption in traffic will occur while the mobile station acquires synchronization on the new frequency.

A second form of handover is the transfer of a mobile station to another base station without a frequency change. This handover has the potential to be a so-called glitch-free or seamless handover that involves no interruption of traffic whatsoever. In fact, as discussed below, according to one exemplary embodiment of the invention a single mobile receiver establishes reception of the new base station before relinquishing the signal from the old base station. During this period where the mobile station is receiving its intended signal from both base stations, the receiver can use both decoded signals to obtain diversity gain. This type of system is also known as soft handover, macro-diversity, or transmit space diversity.

To establish communication with the second base station, the second base station is informed by the network to begin transmitting a signal for the mobile

station. Since it could be disturbing for other mobile receivers already connected in the new cell if a new signal suddenly appeared as one of the higher signal strengths, the new signal is preferably slowly ramped up from a lowest signal strength to a desired power level. This process can also be used when a call is set up from scratch and is known in this context as random access. Until handover is complete, the old base station remains in control of the mobile station's behavior, particularly with respect to controlling the mobile station's transmitter output power. In implementing power control during macro-diversity or soft handover, the controlling base station can receive information from the other base station or stations regarding the signal strength with which they receive the signal transmitted from the mobile station. Completion of handover occurs when control of the mobile station, including the power control function, is transferred from the old base to the new base. Macro-diversity operation can continue for a while, with the new base now as the master and the old base as the slave, until the mobile station is no longer at the boundary of the two cells and the old base station is informed that it can terminate transmission to that mobile, thereby releasing the code which can then be used for establishing a new call. As the sudden disappearance of a signal among the strongest could also disturb ongoing traffic, the signal is preferably ramped slowly down to a minimum power level before being turned off.

A third type of handover that can be effected is a frequency change upon changing base station. In this case, a seamless handover or macro-diversity operation cannot be achieved unless an internal handover of the first-described type had previously been made to the new frequency. The latter is preferable, but may not always be possible depending on the traffic load on the various frequencies in the two cells. Frequency and code allocation algorithms can be provided that attempt to

distribute these resources to mobile stations according to position so as to achieve desirable loading patterns. Using such algorithms an advantage is provided by means of CDMA coding permitting many calls to take place on the same frequency, so that the mean time between new call set-up or clear-down requests is reduced to a few seconds. It then becomes possible for a handover system to request reservation of capacity on any frequency for use by a mobile station that is about to enter the cell, and such a request will normally be granted within a few seconds. The intelligent network controller also strives at call set-up to allocate frequencies so as to even out the loading on each frequency channel. Frequencies can be allocated or re-assigned by means of internal handovers based on which channel will suffer the least from interference from more distant stations. Using such adaptive channel allocation, the network can effectively transfer capacity on any channel from surrounding cells having light demand to a cell with a peak demand, thus achieving averaging of capacity demand over more than one cell, which provides an increase in useable capacity without risk of momentary overload becoming unacceptable.

The implementation of these above-described types of handovers according to the present invention is effected in the mobile station by control unit 14. Further details of control unit 14 are illustrated in Figure 2. Demodulation results are fed from the CDMA decoder 10 to a demultiplexer or selector 20 in control unit 14. The demultiplexer is controlled by the control processor 23 to select either only data from the current base station with which the mobile station is in communication or data from both the current base station and a new base station to which handover is imminent. Selected data is fed to the traffic decoder 22 and the message decoder 21 which are also controlled by the control processor 23 to accept either data only from the current (old) base station or from both the old and new

base stations. The message decoder 21 processes selected data so as to reduce transmission errors using both error correction decoding and diversity combination techniques and passes decoded messages to control processor 23. These messages indicate to the control processor 23 whether the mobile station shall operate in normal mode, (i.e. decoding traffic and messages from the current base station only), whether it shall operate in diversity mode, (i.e. decoding messages and traffic based on data received from the current base and another base station), or whether the mobile station shall execute a frequency change or transmit code change. Similarly, the control unit includes a message encoder 24 and a traffic encoder 25 for outgoing transmissions. The control processor 23 selects an output from either of these encoders by way of multiplexer 26 which is sent to the CDMA encoder/ modulator 19.

The preferred type of handover is the above-described soft handover which does not involve even a momentary loss of traffic. The operation of a receiver in executing soft handovers according to the present invention will now be described.

A control message is transmitted from the current base station to the mobile station, indicating the CDMA code that a neighboring base station will use to transmit data to the mobile station. This is processed in control unit 14 as further detailed in Figure 2 causing the mobile receiver to look for and demodulate the signal from the new base station. Because it is undesirable to suddenly start new transmissions at a high power level, the new base station preferably starts transmitting to the mobile at low power and gradually increases the power level to a predetermined value. The mobile station continues for the time being to transmit using the original CDMA code, but includes data indicating how well it is receiving the new base station. When the old base station determines from this data that

the mobile station is receiving the new base station transmission sufficiently reliably, the old base station initiates a message instructing the mobile station to regard the new base station as its current base station. The old base station can then cease transmission using the original CDMA code. Because it is undesirable to suddenly terminate a high power transmission, the old base station preferably gradually reduces the power level of that CDMA code transmission to a low power level before ceasing transmission and returning that code to a pool available for establishing new communications.

The operation of the mobile transmitter during soft handover is preferably analogous to that of the base station network. Initially, the mobile station continues to transmit using its original CDMA code. The current base station informs the new base station to look for and demodulate the mobile station's transmission using this code. When employing subtractive CDMA demodulation in which all signals are demodulated and subtracted in signal strength order, the new base station would most likely already have been demodulating the mobile signal. The new base station can exchange demodulated data with the old base, for the purposes of using the data diversity to obtain better error correction decoding. This exchange preferably takes place by means of fiber-optic data links between the base stations, carrying multiplexed data pertaining to a plurality of mobile stations, but can also take place via any other type of communication links such as coaxial landlines, trunks or dedicated microwave radio data links.

When the mobile station receives a message from its old base station notifying it to regard the new base station as its current base station, the mobile station starts transmitting to the new base station using the new base station's CDMA code. Since it is undesirable to start a transmission suddenly at high power, the mobile station preferably ramps up the power level of the new

code from a low power level to the desired power level. The desired power level can, for example, be determined according to the method disclosed in U.S. Patent Application Serial No. 07/866,554, entitled "Duplex Power Control" which was filed on April 10, 1992 and is hereby incorporated by reference. Therein, the power level is adjusted based on the relative signal strength the mobile station receives on its code from the new base station compared to other codes from that base station.

A preferred modulation method is a linear modulation method including both amplitude and phase modulation for best spectral containment. The mobile transmitter power amplifier for such modulation is thus of linear type, such as class-A, class-B or class-AB. Such an amplifier is not constrained to being able to transmit only one CDMA coded signal, but is able to transmit a plurality of superimposed signals, so long as their sum never exceeds the amplifier peak power capability. This ability can be employed by the mobile transmitter to permit initiation of transmission to the new base station using a new access code before terminating transmission to the old base station using the old access code. Since sudden termination of transmission using the old code is undesirable, the mobile station can gradually reduce the power level of transmission using the old CDMA code at the same time as it gradually increases the power level of transmission using the new code, in such a way that the sum of the two signals never exceeds the peak power capability of the transmitter. At the crossover point where both superimposed transmissions are of equal power, the peak signal amplitude of each must be halved for the sum never to exceed unity, and the power in each transmitted code signal is thus 1/4. The total power transmitted from the mobile station is thus halved, but since both base stations receive transmissions using both codes, quadruple diversity is in effect provided, more than

compensating for this 3dB reduction in mobile power. For this reason, it can be advantageous to prolong the period during which soft handover is in operation as long as a mobile station is near the edge of two cells. This mode of operation can be termed macrodiversity, and takes advantage of the CDMA receiver's ability to receive two or more CDMA codes simultaneously bearing the same information, and, conversely, the mobile CDMA transmitter's ability to transmit two CDMA coded signals bearing the same information.

When handover requires a frequency change because the new base station cannot provide a signal for the mobile station on the old frequency, it is not as feasible to achieve a handover without interruption of traffic flow. This is partly due to cost constraints in fabrication of the mobile station which dictate that only one frequency synthesizer be used jointly by both the transmitter and receiver. Given this limitation, it is not possible for the transmitter and receiver to change frequency at different times. If, on the other hand, two synthesizers are considered acceptable from a cost standpoint, the receiver frequency could be switched at a time when the downlink side of the conversation is silent, and the transmit frequency could be switched at a time when the uplink side of the conversation is silent.

In situations where a mobile station has a single frequency synthesizer it is, of course, desirable to take advantage of an opportunity to switch frequency when both sides of the conversation are silent. If this is not possible, however, the least perceived disruption in a conversation will occur if the frequency is switched just at the time one side or the other of the conversation becomes silent, as there can be a delay before the other party commences talking.

If such an opportunity does not arise before handover becomes urgent however, a handover is forced by transmitting from the current base station a channel

change command to the mobile in place of speech traffic, the channel change command being a data message containing details of the frequency, new base station ID and new CDMA traffic code that the mobile station shall use. The mobile station then terminates transmission on the old frequency during a pause in conversation as described above, changes frequency, and then starts transmission on the new frequency. Meanwhile, the new base station is informed by the old base station to expect the mobile station's signal. In the event that both base stations are able to receive on both the old and new frequencies, space diversity reception, as previously described, can be provided on both the old and new frequencies to improve reception quality while the mobile station is in the handover region.

There is no point in the old and new base stations transmitting to the mobile station simultaneously on different frequencies however, as the mobile station, in contrast to the base station, is only equipped to receive on one frequency at a time. Ramping up the power level of the transmission from the new base using the new CDMA code can nevertheless be done before, or in parallel with, ramping down the power level of the old transmission so that both will in fact overlap for a short while and the interruption in traffic as the mobile changes frequency is not unnecessarily prolonged by having to wait for the new base station's transmission to appear.

A base station network for implementing handover as described above is illustrated in Figure 3. A first base station 32 having an antenna system 30 and a

CDMA transmitter/receiver system 31 is connected by communications links, for example fiber-optic lines, to one or more base station controllers 36. A second base station 35, having an analogous antenna 33 and transmitter/receiver 34, to which a mobile station in communication with the first base station will now communicate is also connected by similar links to the base station controller.

The base station controller can simply switch data through from one base to another under command of a switching center. If the controller operates in this manner, the diversity combination described above can be implemented in the first or second base station or both. Alternatively, the base station controller itself can perform the diversity combination or selection of data from two or more base stations. Moreover, error correction decoding subsequent to diversity combination can reside at base stations 32 and 35, at base station controller 36, or at the switching center. Likewise any digital speech decoding subsequent to error correction decoding can reside in any of these locations.

While the present invention has been described with reference to exemplary embodiments thereof, these exemplary embodiments are intended to be merely illustrative of the present invention rather than limitive. For example, although the above-described exemplary embodiments have been described in terms of mobile stations, the present invention can be implemented using any type of remote station (e.g., portable units). Moreover, while these exemplary embodiments implement macrodiversity using two differently coded CDMA transmissions in the context of the handover process, those skilled in the art will appreciate that such diversity transmissions can be provided during any stage

of CDMA communication, including normal traffic communication. Thus, the present invention encompasses any and all modifications which are within the spirit and scope of the present invention as set forth in the appended claims.

WHAT IS CLAIMED IS:

1. In a cellular mobile radio communications system including at least one mobile station and at least two base stations, a method of transferring communication with said mobile station from a first to a second of said base stations comprising the steps of:

transmitting a signal on a first frequency from said first base station to said mobile station using a waveform encoded with a first code;

sending a transfer indication from said first base station via a fixed network to said second base station;

upon receipt of said transfer indication, transmitting a signal on said first frequency from said second base station to said mobile station using a waveform encoded with a second code; and

receiving at said mobile station said signals transmitted on said first frequency from said first and second base stations and decoding said signals using said first and second codes to produce a first and second demodulated signal.

2. In a cellular mobile radio communications system including at least one mobile station and at least two base stations, a method of transferring communication with said mobile station from a first to a second of said base stations comprising the steps of:

transmitting a control signal on a first frequency from said first base station to said mobile station using a waveform encoded with a first code to inform said mobile station of a second frequency and second code;

sending a transfer indication from said first base station via a fixed network to said second base station;

upon receipt of said transfer indication, transmitting a signal on the second frequency from said second base station to said mobile station using a waveform encoded with the second code; and

upon receipt by said mobile of said control signal, receiving said signal on said second frequency and decoding it with said second code to produce a demodulated signal.

3. A method according to claim 1, wherein said first code includes a first base station code combined with a first access code and said second code includes a second base station code combined with a second access code.

4. The method according to claim 1, further including the step of:

error correcting said demodulated signals.

5. The method according to claim 4, wherein said error correcting step comprises performing diversity selection of symbols from said first and second demodulated signals.

6. The method according to claim 4, wherein said error correcting step comprises performing diversity combination of said first and second demodulated signals.

7. In a cellular mobile radio communications system including at least one mobile station and at least two base stations, a method of transferring communication with said mobile station from a first

to a second of said base stations comprising the steps of:

decoding, at said mobile station, signals received simultaneously from said at least two base stations on a first frequency and quantifying their relative signal strengths;

transmitting a signal from said mobile station indicating said relative signal strengths;

receiving at one of said at least two base stations said signal indicative of signal strengths and sending said signal to a network controller; and

processing said indicated signal strengths in said network controller and selecting one of said at least two base stations to maintain communication with said mobile station.

8. A method according to claim 7, wherein said network controller commands said selected base station to initiate a transmission to said mobile station using an available access code.

9. A method according to claim 7, wherein said access code is composed of a base station code combined with a traffic channel code.

10. In a cellular mobile radio communications system including at least one mobile station and at least two base stations, a method of transferring communication with said mobile station from a first to a second of said base stations comprising the steps of:

transmitting traffic on a first frequency from said first base station to said mobile station using a waveform encoded with a first code;

transmitting a control message on said first frequency from said first base station to said

mobile station using a waveform encoded with a second code;

sending a transfer indication from said first base station via a fixed network to said second base station;

upon receipt of said indication, transmitting a signal on said first frequency from said second base station to said mobile station using a waveform encoded with a third code; and

receiving at said mobile station said signals transmitted on said first frequency from said first and second base station and decoding these signals using said first, second and third codes to obtain a first demodulated traffic signal, a decoded control message and a second demodulated traffic signal.

11. A method according to claim 10, wherein said first code includes a combination of a first base station code with a first traffic channel access code and said second code includes combination of said first base station code with a control channel code.

12. A method according to claim 11 in which said third code includes a combination of a second base station code with a second traffic channel code.

13. A method according to claim 11 in which said third code includes combination of a second base station code and a control channel code.

14. A cellular mobile radio telephone system using Code Division Multiple Access to facilitate handover between a first and second base station comprising:

antenna, filtering, amplifying and downconverting means for producing an analog signal representative of

signals received from said first and second base station on the same frequency;

analog to digital conversion means for converting said analog signal to a sequence of numerical values;

CDMA processing means for processing and decoding said numerical values using a first and second code to obtain demodulated data signals received from said first and second base station transmitters and measurements of their relative signal strengths or qualities;

encoding means to encode said signal strength or qualities into a data message; and

CDMA transmitting means to transmit said data message.

15. A mobile station according to claim 14, wherein said first code includes combination of a first base station code with a first access code and said second code includes combination of a second base station code with a second access code.

ABSTRACT

A method and system for facilitating handover in mobile radio communication systems are ~~disclosed~~ illustrated. The mobile unit assists in making handover decisions by monitoring the signal strength of control channels transmitted by base stations in neighboring cells. During the handover, the mobile station can receive the same information from and/or transmit the same information to a plurality of base stations to provide diversity combination and improve transmission quality.

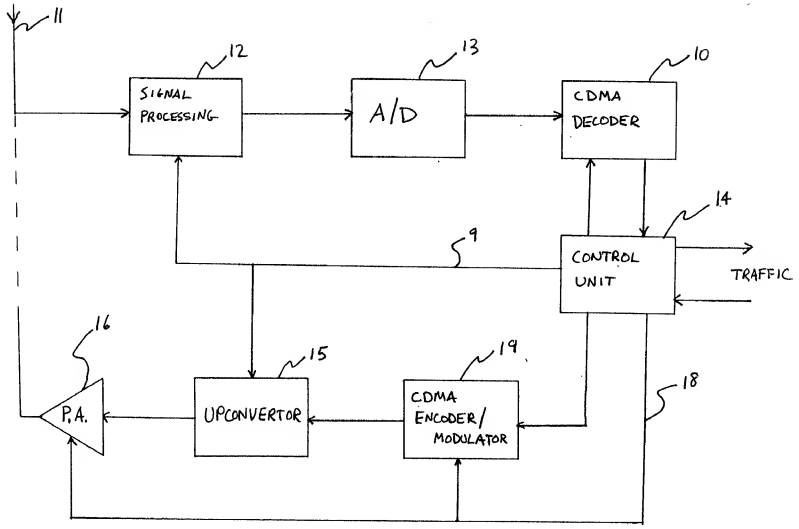

11
12
SIGNAL PROCESSING
13
A/D
10
CDMA DECODER
14
9
CONTROL UNIT
TRAFFIC
16
15
19
18
P.A.
UPCONVERTOR
CDMA ENCODER/ MODULATOR

Fig. 1

FIGURE 2: CONTROL UNIT IMPLEMENTING THE INVENTION

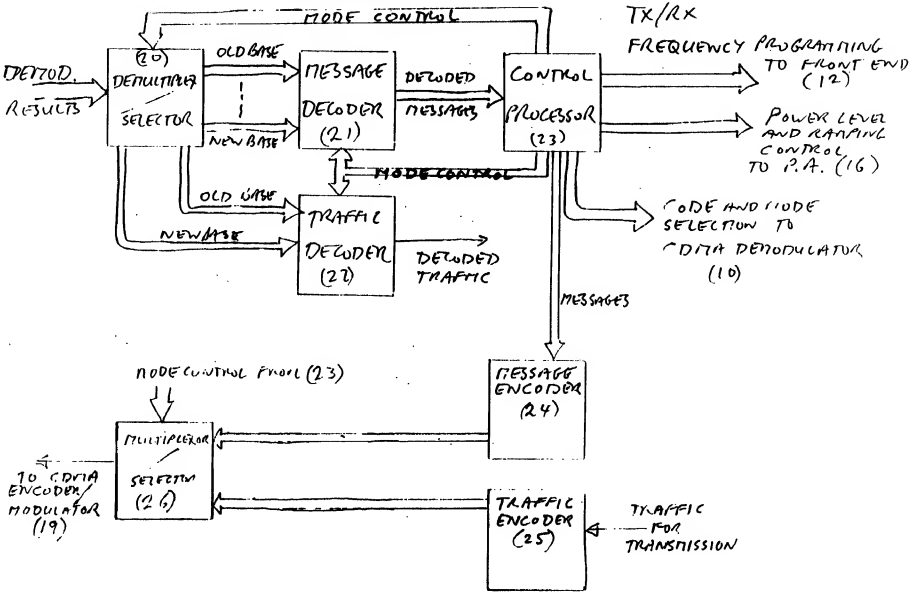
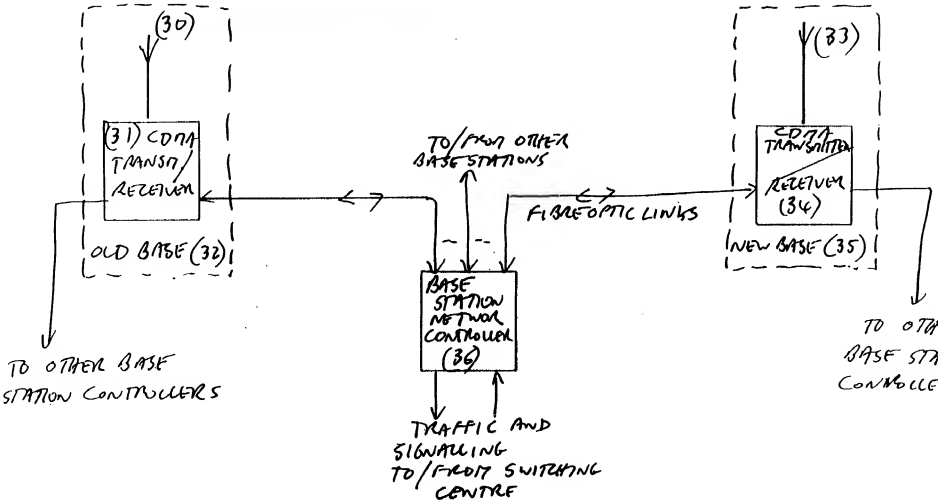


Figure 3: BASE STATION NETWORK ACCORDING TO THE INVENTION.



#3

COMBINED DECLARATION AND POWER OF ATTORNEY FOR UTILITY PATENT APPLICATION

Attorney Docket No.
027500-386

As a below-named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name;
I BELIEVE I AM THE ORIGINAL, FIRST AND SOLE INVENTOR (if only one name is listed below) OR AN ORIGINAL, FIRST AND JOINT INVENTOR (if more than one name is listed below) OF THE SUBJECT MATTER WHICH IS CLAIMED AND FOR WHICH A PATENT IS SOUGHT ON THE INVENTION

ENTITLED: MOBILE ASSISTED HANDOVER USING CDMA

the specification of which

(check one) ☐ is attached hereto;
☒ was filed on April 17, 1992 as

Application Serial No. _____

and was amended on _____ ;
(if applicable)

I HAVE REVIEWED AND UNDERSTAND THE CONTENTS OF THE ABOVE-IDENTIFIED SPECIFICATION, INCLUDING THE CLAIMS, AS AMENDED BY ANY AMENDMENT REFERRED TO ABOVE;

I ACKNOWLEDGE THE DUTY TO DISCLOSE INFORMATION WHICH IS MATERIAL TO THE EXAMINATION OF THIS APPLICATION IN ACCORDANCE WITH TITLE 37, CODE OF FEDERAL REGULATIONS, Sec. 1.56 (a) which states: "A duty of candor and good faith toward the Patent and Trademark Office rests on the inventor, on each attorney or agent who prepares or prosecutes the application and on every other individual who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application. All such individuals have a duty to disclose to the Office information they are aware of which is material to the examination of the application. Such information is material where there is a substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent. The duty is commensurate with the degree of involvement in the preparation or prosecution of the application.";

I do not know and do not believe the said invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to said application; that said invention was not in public use or on sale in the United States of America more than one year prior to said application; that said invention has not been patented or made the subject of an inventor's certificate issued before the date of said application in any country foreign to the United States of America on any application filed by me or my legal representatives or assigns more than twelve months prior to said application;

I hereby claim foreign priority benefits under Title 35, United States Code Sec. 119 and/or Sec. 365 of any foreign application(s) for patent or inventor's certificate as indicated below and have also identified below any foreign application for patent or inventor's certificate on this invention having a filing date before that of the application(s) on which priority is claimed:

COMBINED DECLARATION AND POWER OF ATTORNEY

Attorney Docket No. 027500-386

COUNTRY/INTERNATIONAL	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
			YES__ NO__
			YES__ NO__

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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☐ Please see attached continuation page for additional inventors.